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NOTES ON THE FOOD PLANTS AND DISTRIBUTION OF CERTAIN BILLBUGS[1]

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As part of the results of investigations of North American species of billbugs of the genus *Calendra* Clairville and Schellenberg,[2] it is thought desirable to publish the following notes, with the hope that they may lead to a further knowledge of the genus.

The areas of particular study involved in these notes were selected in anticipation of their reclamation for agricultural purposes, with the dual purpose of ascertaining the primitive or natural status of the different species and of preventing crop losses through knowledge of actual infestations.

Environments varying from typical reclaimed lands to lands almost primitive (fig. 1) have been found in Missouri in dredged drainage ditches immediately east and west of Charleston, in Big Lake, north of Charleston, in waste land near Dudley, in a rice farm in the same basin and one mile north of Dudley, in a drained basin near Advance, and in a large area in process of drainage at Woodrow, a pioneer settlement in the Little River drainage district about five miles southwest of Lilbourn. The Charleston east ditch begins at the outlet of a city surface sewer, about a square south of the Eugene Field School building. The dominant vegetation in this ditch is rice cut-grass, *Leersia oryzoides,* common cat-tail, *Typha latigolia,* beard grass, *Andropogon virginicus,* wild rye, *Elymus virginicus,* with other grasses, sedges and rushes. The rice cut-grass and the cat-tail formed sods all the way across the bed of the ditch at places, and reached perhaps half way up the sides. The beard grass and the wild rye occur in bunches or infrequent patches along the top of banks, at lateral ditches and occasionally half way down the inner slope of the banks.

The west ditch begins at the southwest quarter of Charleston, at the intersection of the County and Air Line Roads, and follows the Air Line Road nearly a mile. The common cat-tail and the rice cut-grass were here also the dominant forms of vegetation. This ditch was used considerably as a dump and received surface sewage of greater pollution. The surface soil, both east and west, is sandy. Billbug infestation in each of these ditches was limited to the first half mile or so, though there were occasional beds of the cat-tail all the way to the junction of the two ditches, less than two miles from the ditch heads.

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[1] Published by permission of the Secretary of Agriculture.

[2] Dr. W. D. Pierce established the priority of this name over *Sphenophorus* Schonherr in February, 1920.

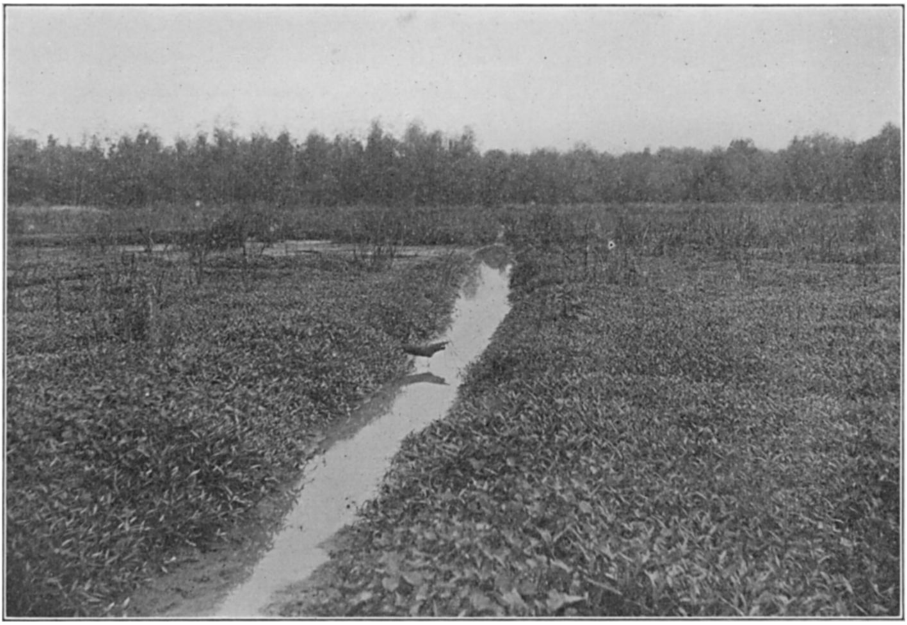

FIG. 1. View south of Woodrow, Missouri. The habitat of *Calendra glyceriæ* and *C. glyceriæ* var. *missouriensis* Chttn. is shown near the woods at the left. Knife flag is prominent.

Big Lake, the nearest point of which is about two and a half miles from Charleston, forms a shallow basin extending from the Mississippi River about 12 miles toward Diehlstadt. Cypress, sweet gum, elms, oaks, hickories, sycamore, hackberry and willows are among the most prominent trees, and the buttonbush the most common shrub, in this portion of the basin. Knife flag, *Zizaniopsis miliacea,* is the dominant grass, with large areas of river rush, *Scirpus fluviatilis,* in places, various broad-leaved aquatic plants, some small grasses, sedges and rushes in lesser significance, and some Indian rice, *Zizania palustris,* occurring in a small area four miles from Charleston.

Dudley, prominent through the success of an artificially irrigated rice farm consisting of a section of land one mile north of town, is in the typical southeast Missouri bottoms. A dredged ditch crosses the Cairo branch of the Missouri Pacific Railroad. Occasional heavy rainfalls sweep much drift from the land west of the ditch to the intersection of the ditch and the railroad. In this area a sedge, probably *Carex lurida,* is dominant in the north margins of the railroad right-of-way, with beaked rush, *Rynchospora corniculata,* smaller sedges and rushes, *Paspalum* and other grasses in the general area. The rice farm, draining this way, may influence the list of species of billbugs occurring about the drift area.

An area known as the " Big Field," a recently drained marsh or shallow lake about 4 miles east of Advance, consists of peat, first plowed in 1917 and with corn as first crop in 1918. A considerable infestation of common cat-tail, with some wild Iris and small cane, continued to grow with the corn. The cat-tail billbug, *Calendra pertinax* Oliv., not otherwise discussed in this paper, was heavily infesting the cat-tail and the chief destroyer of the corn, as observed June 14, 1919. At the edges of this " Big Field " of 1,200 acres there is considerable timber, still sufficiently wild to harbor timber wolves.

In the vicinity of Woodrow, a settlement about 6 miles southwest of Lilbourn, timber is being cleared and the drainage project completed. The water level was sufficiently reduced to permit some crop production in 1918 and more in 1919. On August 20 and 21, 1919, the writer found the fields and roads dry, and water in the dredged ditch less than 2 feet wide in places. The billbug host plants most prominent here are the knife flag, *Cyperus erythrorhizos, Rynchospora corniculata* and *Glyceria septentrionalis.* Of these, the knife flag occupied more ground in the undrained areas than any one of the others. *Cyperus erythrorhizos* appeared to be the most abundant on the roadway and on stump mounds in the cultivated field. In May the *Glyceria* or manna grass was scarce in the wet area of the cultivated field, but common where water was abundant and the soil not broken. The *Rynchospora* or beaked rush was frequent at roadsides, field margins and on stump mounds, as small clusters, and occasionally, in unbroken swamp margins, as patches of considerable size. In the natural condition of these bottoms (fig. 1) the knife flag dominates the open, untimbered marsh areas from the Cape Girardeau neighborhood to Kennett and southward, though not preventing *Cyperus erythrorhizos* and other plants from developing in large blocks at various places. In this Lilbourn area the trees appeared to be as at Big Lake, with willow occupying large stretches of land almost to the exclusion of any other species of tree, and competing with cypress trees for height.

The following notes on the several species listed are exclusive of the eleven species—*Calendra parvulus* Gyll., *zeae* Walsh, *aequalis* Gyll., *maidis* Chttn., *callosus* Oliv., *discolor* Mann., *pertinax* Oliv., *destructor* Chttn., *venatus* Say, *phoeniciensis* Chttn., and *minimus* Hart—given in Farmers' Bulletin No. 1003, and are inclusive of data supplied by correspondents, by submission of material for study, and by contributions of specimens, officially and personally.

Calendra ludovicianus Chttn.

Calendra ludovicianus, one of our largest billbugs, at the time it was described in 1905, evidently limited to the Gulf Region and known only from Louisiana and Texas, has been reported by Mr. J. D. Mitchell, Victoria, Texas, October 8, 1918. He writes: "It is a very common weevil in this section, but I have never been able to find its host plant or the immature stages. I can give you a few notes on the adult. First, it is known here as the 'chicken weevil,' because it is supposed by farmers to kill chickens. They fly in the day time, and chickens catch them; with their powerful legs and claws, they fasten to the chicken's mouth or throat, and refuse to go up or down. The only hope for the chicken is for the weevil to be removed by hand. I have had more than a dozen brought to me from this source. One farmer reported that a flight of the weevils came to his place one day and he and his children relieved fifteen chickens and one turkey during the day. He brought me the weevils as evidence. Second, I have found the adults out at all times of the day and in all sorts of weather—one flying in at the car window and lighting on my coat. Third, I have often found the adults in cells in winter, under timbers, logs and so forth, in the vicinity of lakes and the river. The cells would be in the earth, but flush with it, so, when the timber was removed, the weevil was in sight. I have found as many as five under one piece of timber, on the margin of Green Lake, Calhoun Co., Tex." While the poultry referred to by Mr. Mitchell does not represent a host of *Calendra ludovicianus,* the narration of the observed habits, as given with the locality and habitat notes, is interesting, though not new.

Under date of December 20, 1917, Dr. Haseman, of Columbia, Missouri, kindly submitted specimens of *Calendra* sp. from his office and from the student collections. In this lot was one male *C. ludovicianus,* without data. While its origin is unknown, there is the suggestion that it may have been collected locally by a student.

On September 6, 1918, the staff of the Charleston laboratory, consisting of Messrs. H. R. Painter, R. A. Blanchard, B. S. Reid and the writer, discovered a clue to the distribution and host plants of *C. ludovicianus* at Big Lake, a few miles north of Charleston. A large collection of roots, aerial and aquatic rhizomes and stalk bases of knife flag, *Zizaniopsis miliacea,* was made; the roots were washed at the lake and taken to the laboratory for careful examination. This grass is known throughout the southeast Missouri bottoms by the common name given above. It is a coarse, very sharp-edged grass with flag-like leaves, standing three to twelve feet high, with flower spikes resembling wild rice, and propagating by seed, by aerial runners which may have two or more well-developed plants to a runner before either plant will have come in rooting reach of the soil, and by submerged rhizomes. About 90 percent of these plants were more or less excavated by larvae of a *Calendra,* all apparently one species, and many larvae dead in their excavations, ranging in appearance from life-like to mere whitened remains, and one larva, outside of the plant, alive. This larva change to a pupa and died. Subsequent collections of adults, larvae and pupae made the determination of this specimen possible.

The larval work seemed to be almost exclusively in the bases of the leaves at the root crown, rarely entering the crown, which is very hard, or to the rhizome. No satisfactory evidence was found of the point of oviposition. The larval exits were nearly always above the root crown. Sometimes the chief excavation was in the thickened base of an outside leaf. Excavations in rhizomes or below the base of leaf stalks seemed accidental, as if the larvae sought to escape from the plant for the purpose of pupation, and bored through roots or other obstacles indiscriminately.

On October 2 another collection of roots of this same host plant was made at the same place and examined at the Lake. About 75 or 80 percent of these showed work of *Calendra* larvae, apparently of the same species, in and below the root crown. The apparent difference in place of larval excavations in the first collection and in the second is not fully understood, though the lapse of a month at this time in the season may explain it in part. At this time the remains of only one larva was found. One living pupa was found in mud under a plant of this knife flag. While it did not transform, it developed so far that its pronotal characters were the same as in the adult, except in density of color.

On October 5 one adult male *C. ludovicianus*, several living pupae and larvae, and several dead larvae were taken. One pupa was in its cell in a stem above the root crown and one larva in its prepupal condition was in the base of a stem taken to be an aerial rhizome. The adult and several other specimens appeared to be close to, but outside of, the plant tissue, as if pupation normally occurs outside of the plant in the soil. The pupa cells appear never more than an inch or so lower than the rootstocks or rhizomes, which in turn are practically always within five inches of the surface of the mud. Except for small, fibrous-rooted plants, this was a pure stand of knife flag. A short distance away was a dense growth of *Scirpus fluviatilis* showing no *Calendra* infestation. These examinations were made in mud saturated with water, and some sods excavated last were left stacked five days to dry out. The subsequent examination was more favorable, in that the mud was not dripping nor quick to obscure the view of uncovered insects or their excavations, and the roots had somewhat shrunk away from the mud. One adult male was found in a cell in a rootstock, another in its pupa cell in a stem about one inch above the crown. One pupa was found in its cell in a rhizome, close to the root crown, and a pupal exuvium was found in a cell in a rootstock below the crown. Thus the rule seems open whether or not pupation shall occur in the host plant. The heavy mortality found in these several examinations of the host plant in Big Lake is credited to an unusual lowering of the water level by a long drought, followed abruptly by unusually high water for a period of time sufficient to drown most larvae, many of which were intact in their excavations September 6, but leaving generally unnoticeable remains on October 2 and later dates. Two examinations made in this same area in 1919, before the drainage system had changed conditions, failed to show specimens or work of this species of *Calendra* as survivors of their misfortune of last year.

At Woodrow, some miles southwest of Lilbourn, one female *C. ludovicianus* was taken under an isolated plant of knife flag, and one male under each of two plants of *Cyperus erythrorhizos* on August 20 and 21, 1919. While two of these were associated with this second possible host plant, they were not found feeding, and were there probably only for temporary shade.

Calendra costicollis var. *callosipennis* Chttn.

On March 29, 1919, the writer found two males and one female of this variety of billbug, along with specimens of *C. destructor* Chttn., *C. callosus* Oliv., and *C. scoparius* Horn., under drift in the northwest angle of the Cairo Branch of the Missouri Pacific Railroad and the dredged ditch east of Dudley. Lying one mile north of this accumulation of drift, and possibly affecting the list of species of billbugs occurring here, is a 640-acre rice farm.

On June 18 Mr. H. R. Painter collected a larva of this *Calendra* in a species of *Carex*, probably *Carex lurida*. Fed upon timothy, it became an adult on August 5, 1919, a female. This host plant forms an almost pure culture for many yards along the north side of the railroad right-of-way.

On October 25, 1919, the writer found one male of this billbug in its pupa cell in a stalk of the *Carex*, at a time when several inches of water covered all the ground where this host plant was dominant. Several stalks showed larval work. There appeared to be no distinguishing character between the larval work of this species and of other species of *Calendra* which are able to mature within the stalk of a grassy sedge of the size of this *Carex* or of *Cyperus strigosus*. Pupation occurred in the cut-off stalk, the cell being about one half inch long, while about five sixteenths of an inch of frass-packed excavation remained between the cell and the point at which the larva cut the stem completely through.

In cages, the adults taken in March fed on stalk sections of manna grasses, *Glyceria septentrionalis* and *G. nervata*, wheat, orchard grass, blue grass, rye, and on a sheathed timothy head. They fed somewhat at the end of a section of *G. septentrionalis* when supplied with no alternative food; freely on wheat, less freely on orchard grass and not at all on the others when fed wheat, orchard grass, *Elymus* and *Leersia* simultaneously. The beetles fed freely on the interior of rye and blue grass stalks and on a sheathed timothy head, very slightly on the node of orchard grass and not at all on cheat, when a section of rye stalk including the node next below the head, a section of cheat stalk with node about eight inches above the ground, a section of blue grass stalk close to the ground, a sheathed timothy head and a section of orchard grass with node, were supplied simultaneously. They fed moderately on orchard grass, freely on *G. nervata* rootstock and very heavily on a section of a soft shoot of *G. nervata,* when these last types of food were simultaneously supplied.

Calendra cariosus Oliv.

Two male specimens of *Calendra cariosus* were submitted by Mr. W. R. McConnell, March 26, 1917, collected by him at Greenwood, Mississippi, one in a clump of *Andropogon,* March 21, 1913, and the other on ground under garden peas, September 12. While it is possible that neither plant is a host plant, it is most probable the *Andropogon* was food for the adult while concealed, perhaps hibernating, in the clump.

On August 20 and 21, 1919, the writer found numerous adults of *C. cariosus,* some mating, in and around a beaked rush, *Rynchospora corniculata.* Several were clasping stems, both within and outside of leaf sheaths, and eggs were laid freely under leaves of this plant in cages. Of the larvae collected in *Rynchospora* in the field one produced a female *C. cariosus* adult on October 8. Thus this plant is host both of adults and of larvae. One adult was taken with its beak inserted into the stalk of *Cyperus erythrorhizos,* with numerous other specimens associated in the adult stage with this host plant.

These observations were made at Woodrow. *C. cariosus* adults appeared in *Rynchospora* at the east side of a corn field along the edge of standing timber. A short distance from the fence, in the corn field, where old tree stumps prevented cultivation for a little space around, *Cyperus erythrorhizos* and *Rynchospora corniculata* were infested with both *C. callosus* and *C. cariosus.* The former was common and latter infrequent in the interior of the corn field and westward, as well as along the roadside at the north of the field where the trees had been cleared. It therefore appears that proximity to timber is preferred by *cariosus.* This corn field showed less than 20 percent of a normal stand and was sown to cowpeas. Many corn plants showed typical billbug injury, strongly indicating that the whole corn loss was attributable to the billbugs, undoubtedly in part to *cariosus,* even though *callosus* was dominant in the interior of the field. One *C. cariosus* was reared to the adult stage in sections of corn stalk in the laboratory.

Under date of July 29, 1918, Mr. J. D. Mitchell wrote: "In June, 1917, I found *C. cariosus* associated with two unidentified species of *Calendra,* destroying rice in Matagorda County, Texas. The land was freshly broken fallow. The native food plant of the weevils had been destroyed and they ate the rice as a substitute." The two associated species to which Mr. Mitchell referred are *C. scoparius* Horn and *C. germari* Lec.

Calendra ulkei Horn.

One female specimen was contributed by Mr. George I. Reeves, collected as a larva by Mr. E. J. Vosler, among the roots of blue grass in a pasture at Salt Lake City, Utah, April 8, 1912, and reared in a pot in the screen house of the laboratory at Salt Lake City, by July 18, 1912. Under date of April 26, 1917, Dr. Chittenden regards *ulkei* as probably a valid species, with this the first record he has ever received of its true habits, though the species is common in Wyoming, Colorado, New Mexico, Arizona, and northern Mexico.

Calendra scoparius Horn.

In a collection of *Calendra* sp. submitted December 20, 1917, by Dr. Leonard Haseman, were three specimens of *C. scoparius,* marked " C. Mo., July."

On July 29, 1918, Mr. J. D. Mitchell wrote that this species was associated with *C. cariosus* and *C. germari,* destroying rice fields in Matagorda County, Texas, June, 1917.

On September 11, 1918, the writer, in company with Mr. H. R. Painter, found an adult female of this species in a position as if feeding, below the level of the soil surface, on the base of a sedge stalk growing near the water horizon in the dredged ditch east of Charleston.

On March 29, 1919, the writer found a female under drift at Dudley. On June 18, at this same place, Mr. Painter collected a male in a small patch of *Carex* (probably *lurida*) and grass, and a female about half imbedded in the ground at the base of a grass plant showing frayed tissue, as if she had just been feeding. The male fed on *Carex* placed in the container in which it was carried to the laboratory. On October 25, at the same place, the writer found a male clinging to the root of *Carex,* probably *lurida,* a short time after the plant had been pulled up and laid aside in water among growing plants of the same species and area for later examination. Later a female was found in the act of feeding, head down and beak inserted, upon a slender stalk of this *Carex,* surrounded by mud which was only a fraction of an inch above water, the abdomen protruding slightly above the surface of the mud.

At Advance, June 9, 1919, in a corn field infested with cat-tails, Mr. Painter took one female on cat-tails and one female on corn. The corn in this field was badly hurt last year, and billbugs were working heavily at this time, *Calendra pertinax* dominating, with 18 out of 20 adults collected in this field and 68 out of 70 collected in all the cat-tail infested corn fields visited in this locality being *pertinax,* the other two being the above-mentioned specimens of *scoparius.*

On the occasion of the overflow of the Meramec River, and when the water had receded only about five inches, the writer collected some drifting leaves which rode high on lodged drift at Valley Park, October 30, 1919. On these dry leaves many insects had taken refuge, including one male *scoparius*.

Calendra compressirostris Say

Under date of November 6, 1917, Mr. D. J. Caffrey contributed eight specimens of *C. compressirostris* collected in 1916 under rubbish on the open prairie land in the vicinity of Maxwell, New Mexico, where the predominating grass is Grama (*Bouteloua*). The dates of collection were as follows: two males and one female, May 10; one male, May 24; one male, June 7; one male, July 20; one female, September 11, and one male, October 10.

Under date of May 11, 1918, Mr. J. R. Horton submitted one specimen of *C. compressirostris,* determined by Dr. Chittenden, which was reared from a wheat stem at Wellington, Kansas.

The following data concerning this species were furnished by Mr. J. D. Mitchell, July 29, 1918: "In May, 1918, I received live specimens of *Calendra compressirostris* from Calhoun County, Texas, with the complaint that they were destroying young corn. This had been fallow land, and was planted for the first time. The native food plant of the weevils having been destroyed, they ate the corn as a substitute."

Calendra melanocephalus Fab.

The first specimen of this species taken by the writer was associated with specimens of *C. zeae* Walsh and *C. destructor* in timothy sods at the edge of a low-lying corn field near Athens, Indiana, July 27, 1915. Hay was harvested from this field in 1912 and 1913, the stubble was pastured in 1914, and corn was planted in 1915. On July 8 base leaves showed billbug perforations. On July 27 the corn was large and thrifty, as if it had outgrown the injury.

At Charleston collections of this species were made by the laboratory staff in August and September, 1918, and June and November, 1919. On August 13, last year, a large series of *Calendra* larvae was collected almost exclusively within plants of the common cat-tail. From this series one female issued August 27. The cat-tails here were growing two or three feet above the water level where the soil was sandy, in the dredged ditch east of Charleston.

On September 11, in the same ditch and vicinity, a larva of this species was collected with pupae and larvae of *C. pertinax* in soil about the roots of the cat-tail, the adult issuing September 27. This female fed somewhat on sections of wheat stalks during the following spring. From May 31 to June 5 she was furnished with knife flag, but evidently did not feed, and was dead on the 7th. On September 9, in this same ditch, one adult male was found clinging to stems of sedges below the surface of the soil, as if feeding. On September 21 a female was collected in this same ditch. The following spring she fed considerably on wheat-stem sections. From May 31 to June 5 she was supplied with sections of knife flag and fed slightly at one end of one piece. From June 5 to 7 she was supplied with one piece each of knife flag, orchard grass, *Elmyus virginicus* and *Leersia oryzoides*. On the 7th she was clinging to the piece of orchard grass. The leaf sheath covered only part of the section, which measured about two and three sixteenth inches in length. Removed from the stem and held up to the light, the sheath showed about 120 clean-cut punctures, most of which were very fine. The interior of the stem showed four rather large feeding excavations. Some feeding was done at the ends of the *Leersia* section, possibly with one or two cuts through the walls near one end. The *Elymus* section showed only a trace of feeding on the outside surface of the node. From June 7 to 9 three sections of tender shoots, larger in diameter than mature stems, of manna grass, *Glyceria nervata,* and one section of orchard grass were supplied. She fed very heavily on the manna grass, but very sparingly, if at all, on the orchard grass. From June 9 to 13 she was supplied wheat stems and fed somewhat. From June 13 to 24 she was supplied with two sections of manna grass, making frequent punctures. On June 24 she was dead.

On September 28 one male was collected among cat-tails in the dredged ditch just west of Charleston. The same day, in the east ditch, one male and one female, and a larva which later proved to be this species, were taken among cat-tails. The larva produced a female adult on October 4.

On June 12, 1919, Mr. Painter collected three male and four female *C. melanocephalus* on knife flag at Big Lake, Charleston. These were carried to the laboratory with a piece of knife flag in a tin box. When the box was opened one female was in a stem and ten eggs were laid loosely about her. Beyond the nodal partition from her, and one inch from the opposite end of the stem, which was too small to admit an adult, an egg was adhering to the inside of the stem wall in the edge of the node, at a point where a puncture was visible outside, though not noticeable on the inside. A twelfth egg was loose in the vial. One of the resulting larvae, placed in a section of green oats straw, fed, cut out of the one section and entered another, and was dead when next observed.

On November 7, 1919, Mr. Painter collected two females in *Andropogon virginicus* on the bank of the east ditch at Charleston, and on the 10th he found another female in the same grass, a short distance from the collecting point of the 7th.

A male collected at "Westville, N. J., 5–4," and a female at "Bucks Co., Pa., 5–13," were contributed by Mr. H. B. Weiss, and two males, collected by Mr. H. A. Kaeber at "S. Phila., Pa., 4.16.10," were contributed by Mr. H. A. Wenzel.

Calendra glyceriae Chttn. and *glyceriae* var. *missouriensis* Chttn.

A number of specimens of this species and its variant were found by the writer on plants of manna grass in the vicinity of Woodrow on May 23, 1919, ovipositing in this host plant. Some of the adults were close to the soil, apparently wedged in between grass stalks; others were on the soil under the reclining stalks, and at least one was found below the surface of the ground, between a stalk and the soil. From a limited amount of host plant material brought from the field one hundred and thirty eggs and larvae were secured. The field conditions where this infestation was found may be described as reclaimed land, first broken and put to corn in 1918. The grass was growing in an area too low for cultivation at this date, though corn was growing within about ten feet, with very little difference in elevation. A second trip was made to Woodrow on August 20 and 21, with the expectation of making a further study of this species, but without success. The host plant is either short lived or else the artificial drainage of the land has left the plant unable to withstand the summer drought. As the grass was in bloom on May 23, it is presumably short lived. No remnants of the plant were found alive nor significant parts dead, though the precise area where the collection was made was searched carefully, and no plants were to be found alive elsewhere in the neighborhood where it was common in May.

Calendra germari Lec.

Under date of August 26, 1918, Mr. J. D. Mitchell submitted a male specimen of *C. germari,* taken on flooded rice at Buckeye, Matagorda County, Texas, June 8, 1917. In a previous letter of July 29 Mr. Mitchell referred to billbugs, represented by this species, *C. cariosus* and *C. scoparius,* of the same day's collection, as destroying rice.

Two female specimens were taken by the writer at Lawton, Oklahoma: one on June 14, 1918, caught entangled in tar; the second on June 21, along a tar-line, maintained as a barrier against chinch bugs among experimental plats on the Department of Agriculture Experimental Farm at that place. The female taken June 21 lived in a cage for more than three months, and was fed timothy once, *Cyperus strigosus* fifty-seven times, and at the end of three months was given corn grains in a tin box for winter. No eggs were deposited.

Two of the above three were kindly determined by Dr. Chittenden.

SUMMARY

The studies from which the notes in this paper have been obtained have been conducted chiefly for purposes of ascertaining the natural status of the several species and of preventing needless crop losses. Great losses have repeatedly occurred over large areas for the first two years after new land was brought into cultivation. The extensive drainage projects of Southeast Missouri afforded valuable and inexhaustible opportunities for the study of the insects in their relations to natural and cultivated plants on a large scale in advance of, during, and years after reclamation.

The progress of the work of the Little River Drainage District in 1918 made it possible to conduct investigations where such investigations would not previously have been practicable, yet where human agencies had evidently not begun to act upon the billbugs. The same progress, however, made possible some cultivation of new land. Thus it was possible to find at Woodrow cultivated land and nearly complete submergence with native swamp.

At Charleston the ditches under observation were rather old and crowded with native swamp plants, with fields long under cultivation and generally free from billbug host plants. Big Lake, however, at that time not drained, represented very closely the conditions prevailing in the Lilbourn interior swamps at Woodrow.

At Advance reclamation work was finished and land first plowed in 1917. The destruction of host plants was incomplete, and cat-tail flags were present while the second crop of corn was growing. Both the first and second year crops of corn were badly damaged by the billbugs still harboring with the flags. Both crops would have been safe from billbug injury had all host plants been destroyed with the first plowing.

At Dudley one section was under artificial irrigation for rice production. A large basin subject to overflow empties into a drainage ditch at the railroad bridge. The incidental carriage of drift and insects to this point of lodgment appears to have intensified billbug infestation here.

The natural host plants and the billbugs reared from each are:

Carex lurida: Calendra costicollis callosipennis.
Cyperus erythrorhizos: Calendra cariosus, C. callosus.
Glyceria septentrionalis: Calendra glyceriae,[3] *C. g. missouriensis.*[3]
Leersia oryzoides: Calendra melanocephalus, C. minimus.
Rynchospora corniculata: Calendra cariosus, C. callosus.
Typha latifolia: Calendra pertinax.

The cultivated host plants and the billbugs reared from each are:

Blue grass: *Calendra ulkei.*
Wheat: *Calendra compressirostris.*

These notes are not to be regarded as complete or exhaustive on any species. They do, however, represent a definite advance in the knowledge of the group and point to fields ripe for much further investigation.

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[3] This species and variety were associated in numbers, depositing eggs in this plant. None were reared to maturity.

In addition to assistance gratefully acknowledged to persons mentioned in the notes, the writer wishes to express thanks to the Botanical Staff of the Department of Agriculture and to Dr. H. S. Conard, associated with the Bureau of Plant Industry, for determinations of host plants, and to Messrs. W. R. Walton and J. S. Wade for many courtesies.